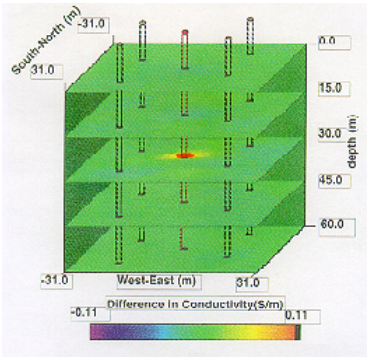
Sandia National Laboratories

Geophysical Technology Department

Focus

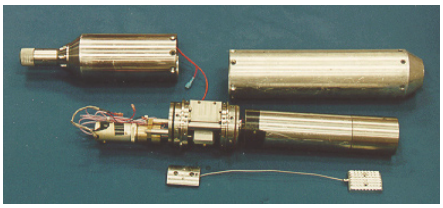
The Geophysical Technology Department develops and implements geophysical techniques for investigating the earth's subsurface. We concentrate on solving problems important to the Department of Energy in the areas of fossil energy, hazardous and nuclear waste management and restoration, defense, nonproliferation, and energy-related basic research. The department staff has a broad range of expertise in seismology, electromagnetics, petroleum and sedimentary geology, thermal geophysics, and mechanical and electrical engineering. This breadth enables us to attack a wide variety of problems ranging from algorithm development and computer modeling, technology design and bench scale experimentation, to field experiments, data collection, processing, and interpretation. Leading-edge geophysical instrumentation development, often with industrial partners and particularly for borehole applications, is an important focus for the department; another major area is seismic and electromagnetic data modeling and inversion.



3-D Image of Salt-Water Plume Obtained from Electromagnetic Data

Capabilities

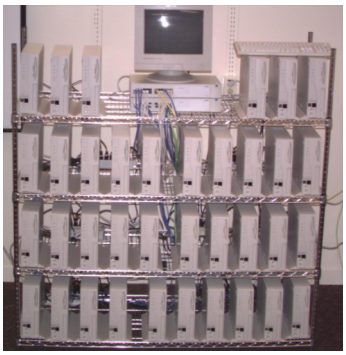
- Geophysical surveys: seismic, ground penetrating radar, electromagnetic
- Development of seismic and electromagnetic modeling and inversion software
- Design, implementation, and interpretation of geophysical and geological field experiments
- Design, development, and testing of geophysical environmental restoration technologies (characterization and monitoring)
- Geophysical data processing, analysis, and interpretation
- Design, development, and testing of borehole instrumentation



Magnetostrictive Borehole Seismic Source

Major Facilities and Equipment

- Unix workstations, including Silicon Graphics, IBM Risc machines, Dec-alpha chip, and access to multiple Sandia supercomputers
- Beowulf Linux Clusters for parallel computations
- Electrical-mechanical laboratories; field experiment staging area
- 48-channel field seismograph, geophones, downhole seismic receivers, downhole seismic sources
- Ground penetrating radar unit, time-domain electromagnetic field equipment
- Field truck and equipment
- Laser confocal microscopy



Beowulf Linux Clusters

Sandia is a multiprogram laboratory operated by Sandia corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

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Selected Projects

Hydraulic fracture diagnostics using microseismic techniques: We are developing a diagnostic system for evaluating the effectiveness of hydraulic fracturing on stimulating natural gas production. This work includes both hardware and software development with extensive field testing at government and industry sites. The emphasis is on detecting and measuring very small seismic events that occur during hydraulic fracturing in order to map the fracture geometry; tiltmeter data are also being examined for diagnostic applications.

Three-dimensional inversion techniques for electromagnetic data: A suite of 2- and 3-D inversion codes for various types of electromagnetic data has been developed and implemented on various platforms, including massively parallel computers. These algorithms are applicable to a variety of problems, such as environmental monitoring, enhanced oil recovery, mining, and defense-related applications.

Global Nuclear Event Monitoring: The recently signed CTBT depends heavily on seismic data and analysis for detection and identification of possible nuclear explosions and their discrimination from earthquakes and industrial explosions. Sandia's role in enabling the CTBT is primarily in automating data processing and analysis for the seismic data stream emanating from a worldwide sensor network. We provide seismological expertise for a number of activities within the GNEM project.

Magnetostrictive seismic source for environmental applications: We have developed a small, light, high-frequency downhole seismic source based on a magnetostrictive actuator. The source is only 4" in diameter and weighs only 50 pounds, but can emit energy detectable over borehole separations of hundreds of feet with frequencies up to 2000Hz.

Single-well seismic imaging modeling: hardware and modeling: Borehole hardware enabling the mating of an orbital downhole source with a 3-component receiver in the same well is near completion. We are using a Sandia-developed 3D elastic finite difference synthetic seismogram code to model the complete wavefields for complex geometries expected for single well experiments near salt dome flanks.

Thermal monitoring techniques for groundwater flow measurement: The in situ permeable flow sensor, a device for measuring the full 3D flow vector in saturated soils, has been developed, tested, and commercialized by a startup technology firm, HydroTechnics, Inc. The flow sensors were used in several Sandia experiments at DOE facilities at Hanford, Savannah River, and the Weeks Island Strategic Petroleum Reserve site. A similar instrument for measuring gas flow in the vadose (unsaturated) zone has also been developed for environmental monitoring.

Underground structures characterization: The ability to locate and characterize underground structures and facilities is largely dependent on geophysical data and interpretation. We are collecting and analyzing unique seismic data sets for developing methods to locate continuous energy sources in real earth situations. We are also using computational simulation to model underground voids in the presence of seismic and electormagnetic wavefields.

Characterization of natural fractures for reservoir evaluation: Because natural fractures control much of the permeability in tight rock formations, we are working to understand natural fracture systems in a variety of environments and use that information for better reservoir characterization and modeling. Extensive field work has led to the development of a substantial data base and experience in natural fracture occurrence and the relationship to the stress state of the rock.

Sandia National Laboratories • Geoscience & Environment Center

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